Space Weather Technical Forecast

Issued on Monday, 19 September 2022 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance G1 minor storm early day 1 (19th). Ongoing chance of M-flares/R1-R2 Radio Blackout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the past 24 hours, with only minor C-class flares. The largest was a C3 flare observed at 18/1540 UTC originating from AR3100. There are currently two numbered sunspots on the visible disc. The most notable is AR3102 Eai/Beta, although its growth now appears to have stalled, and remains relatively magnetically simple. The other numbered sunspot AR3100 Dso/Beta is simple and continues to show signs of decay. However, this region has recently produced a longevity C-class flare, observed at 18/1800 UTC, and produced a CME, which is yet to be analysed. Two newly and currently unnumbered sunspots have also emerged in the southwest quadrant, although these remain small and simple. No Earth-directed CMEs were observed in the last 24 hours

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, increased from initially background levels of near 350km/s increasing to elevated levels, between 500-550km/s due to the arrival of the fast wind of CH23/-. This increase, from around 18/0900UTC followed a decrease in density from slightly above average, peaking 15 ppcc at DSCOVR, before returning to average to slightly above average. The total interplanetary magnetic field (IMF), Bt has been Moderate throughout at 8-12nT with the north-south component Bz, ranging between -9nT and +11nT. While brief periods of negative (southward) field were observed, Bz was more predominately positive (northward). The phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained slightly elevated above background levels over the 24 hours, but less than 2.5pfu. High energy electron flux (greater than 2 MeV) was generally at background to Moderate, with the associated 24 hour fluence remaining well below the Active (1e8 integrated pfu) threshold. Observed fluence at 19/0000UTC was 8.31e6 integrated pfu).

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, but with a chance of rising again to Moderate with any notable flaring of AR3102. Flare risk may also increase as ex-3089 rotates onto the disc by day 2 (20th).

Solar Wind / Geomagnetic Activity: A CME, accounting for the combination of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant, may glance Earth early on the 19th. However confidence is low for the timing of any arrival, with the bulk of the CME material also expected to miss, passing ahead of the Earth. The fast wind of CH23 is expected to peak on day 1 (19th), before easing again towards background levels. Meanwhile, CH25/+ approaching the central meridian is likely to bring further fast winds by the end the forecast period, probably by day 4 (22nd). Geomagnetic activity will be Quiet to Unsettled at first,

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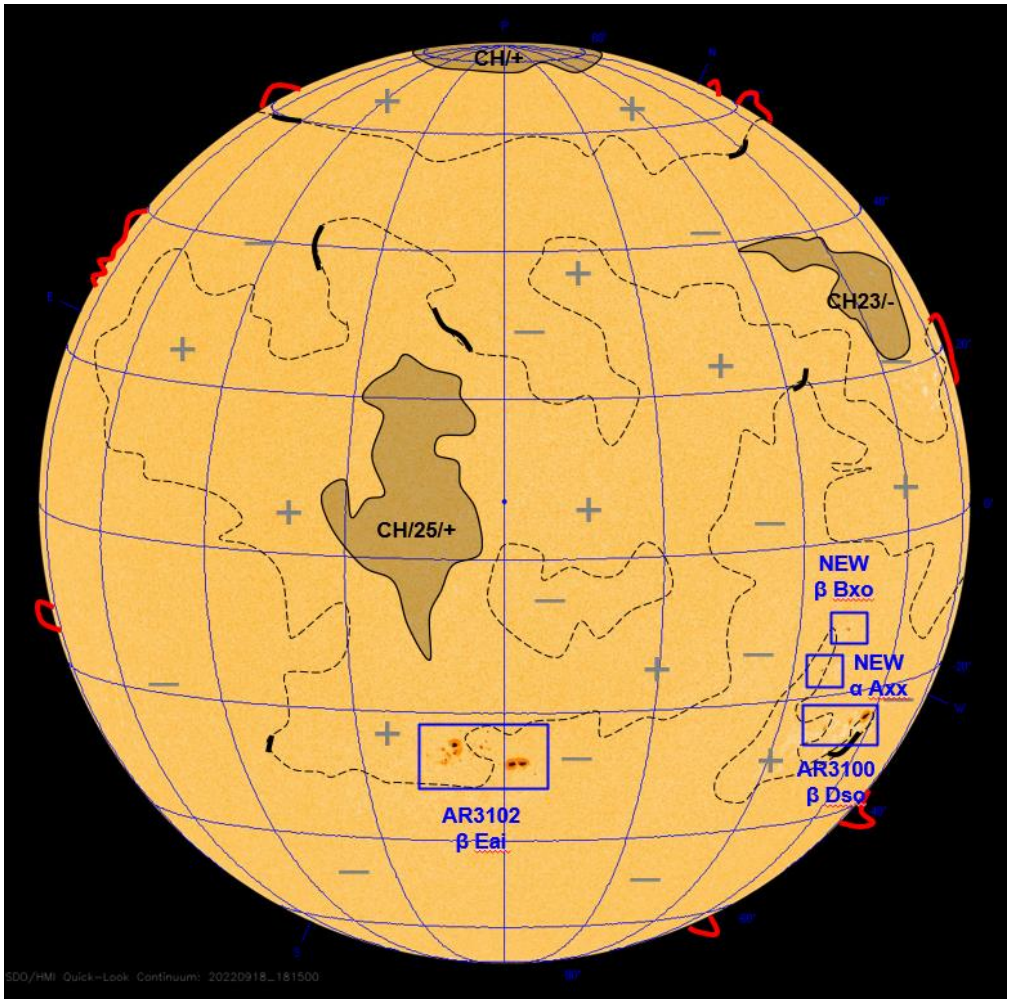
with isolated Active intervals possible. There is a slight chance of G1 Minor Storms early day 1 (19th) depending on any CME arrival. Activity then easing to be mostly Quiet day 2 (20th) onward. Geomagnetic activity probably increasing again by day 4 (22nd) as a fast wind arrives from CH25/+ located centre disc.

Energetic Particles / Solar Radiation: Current very slightly elevated high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to gradually ease through the period. There is only a very slight chance of this rising above the S1 level (10pfu), with any notable flaring that may occur from AR3102, and possibly returning ex-3089 around the east limb in the coming days. The high energy electron flux (greater than 2MeV) is expected to rise day 1 (19th) onward due to recent fast wind and possible CME enhancement, perhaps reaching High at diurnal peak. This will give a slight chance of the 24-hr fluence rising to be Active (1e8 integrated pfu) by the end of the period, but most likely remaining below the Active threshold.

Figure 1. Solar Analysis Valid 18/1815 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME that is expected to pass by Earth, perhaps giving a glancing interaction early day 1 (19th). This is the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. The arrival timing and strength is low confidence due to the background Enlil solar winds being notably different to those currently observed, coupled with only a glancing interaction being indicated.

Earth is currently in a fast wind of negative polarity CH23, with solar winds at elevated levels. Peak winds are likely early day 1 (19th), before easing gradually thereafter, likely returning to background day 2 (20th). However, CH25/+ in the eastern hemisphere is likely to bring fast wind to Earth by the end of the forecast period, although there is uncertainty with this feature, as it did not appear on previous rotation.

Geomagnetic activity will be Quiet to Unsettled at first, with isolated Active intervals possible. There is a slight chance of G1 Minor Storms early day 1 (19th) depending on any CME arrival. Activity then easing to be mostly Quiet day 2 onward. Uncertainty towards the end of the forecast period, with the potential for a fast wind to arrive at Earth from CH25/+.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	1	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil – possible glancing blow from a CME early on the 19th, but confidence is Low.

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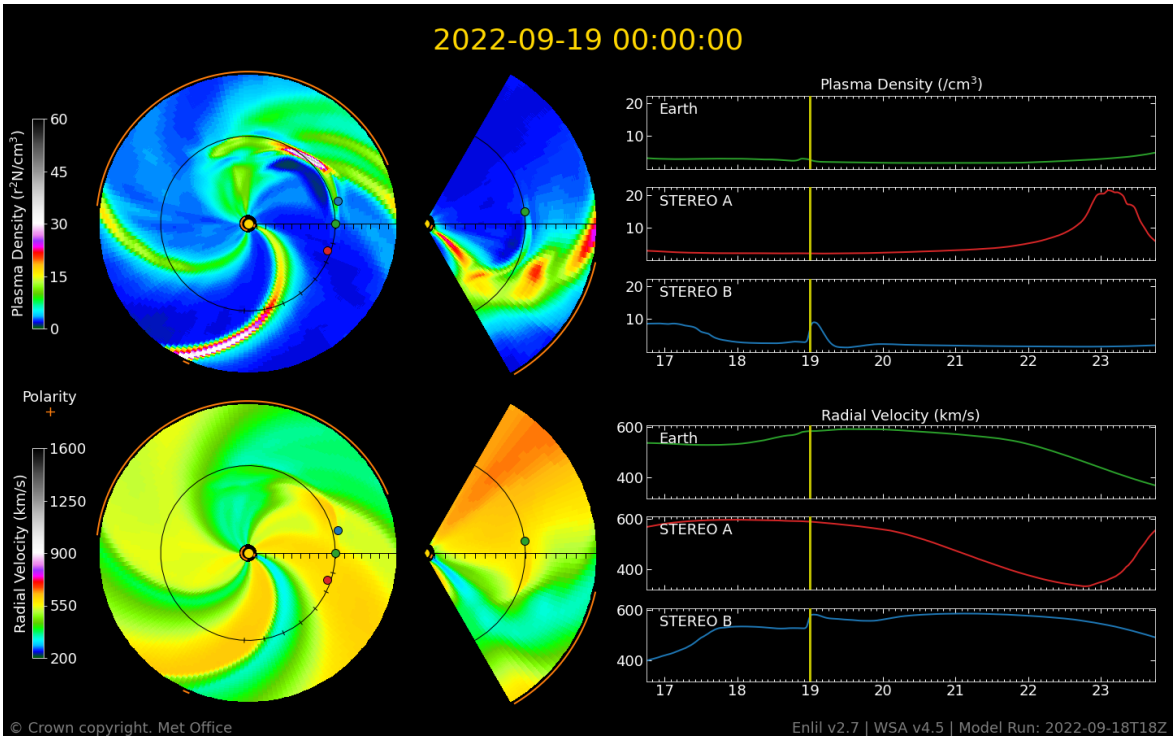
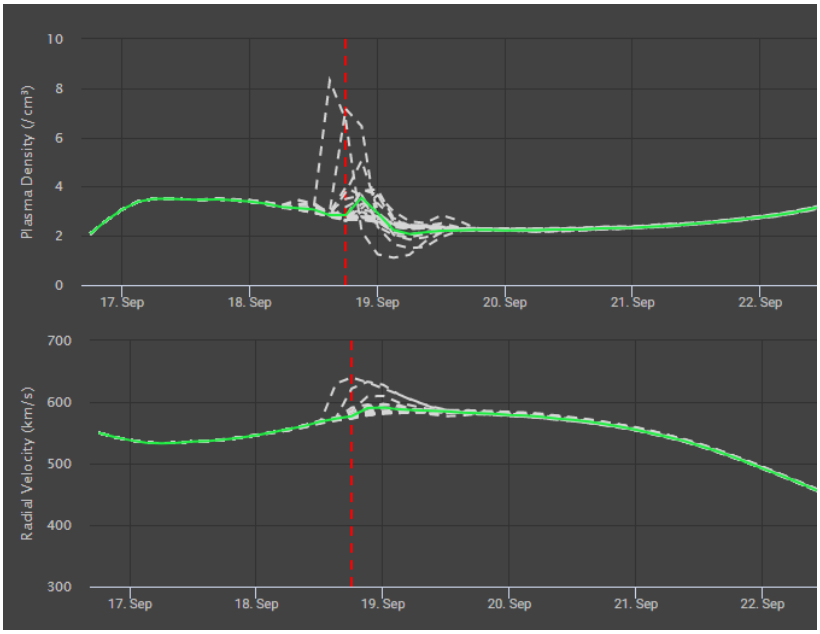
Figure 2: ENLIL and Ensemble – shows a possible glancing blow from a CME early on 19th, but no evidence of it yet! Low confidence.





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Radio Blackouts - X-Ray Flares:
Solar Activity is currently Low, with only minor C-class flares observed in the past 24 hours, but with a chance of rising to Moderate if any M-class flares occur, mainly from AR3102, which is now located near the central southern disc.

There are currently two numbered sunspot regions on the visible disc, with AR3103 Bxo/Beta now decayed. AR3102 Eai/Beta remains the most prominent, although recent growth around its trailing spots appears to have stalled, and the magnetic structure of the spot remains relatively simple. AR3100 continues to gradually fade, especially in its trailing spots. However, this recently produced a longevity C-class flare, resulting in a CME, which is yet to be analysed, awaiting further coronagraph imagery. Two areas of flux emergence to the north of this region, have developed small and simple spots, but are yet to be numbered.

There is also ex-AR3089 which is approaching the southeast limb on the far-side. The looping of this region is visible on SDO imagery, along with a bright region on STEREO euvi. This is expected to rotate on the Earth-facing disc during day 1 (19th), and may increase the flare risk further in the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES16-17 X-Ray Flux

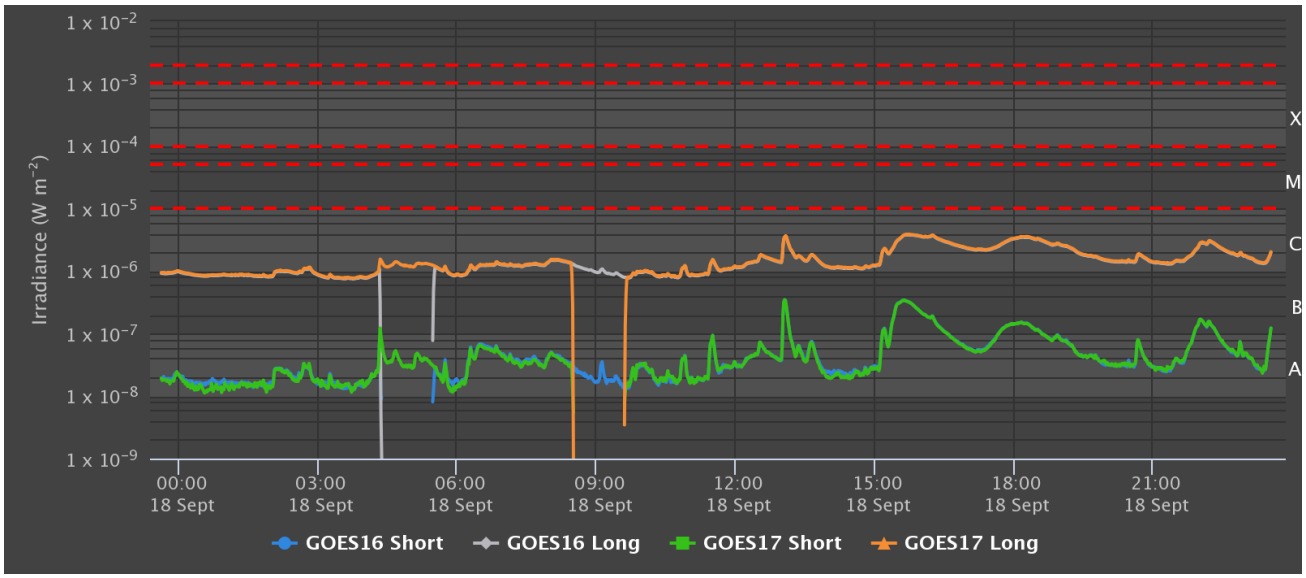

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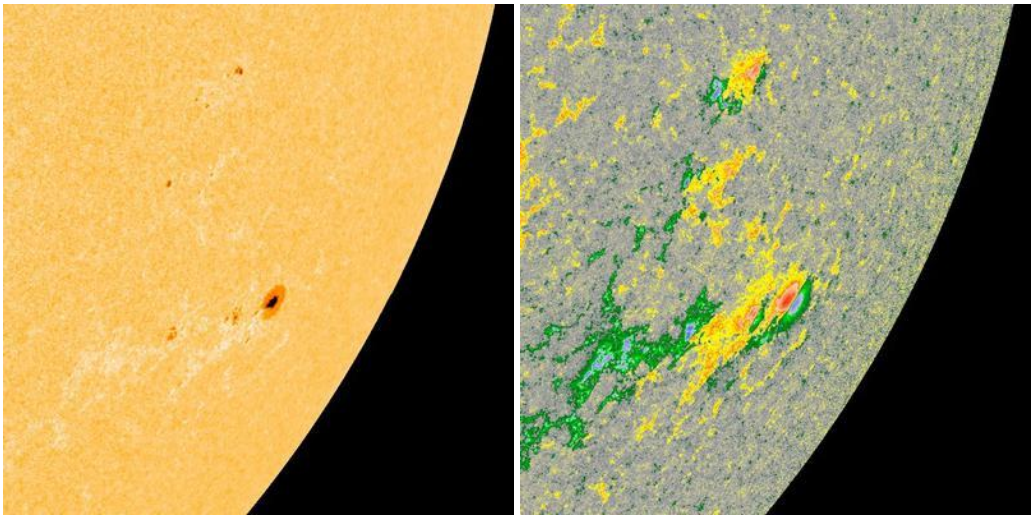
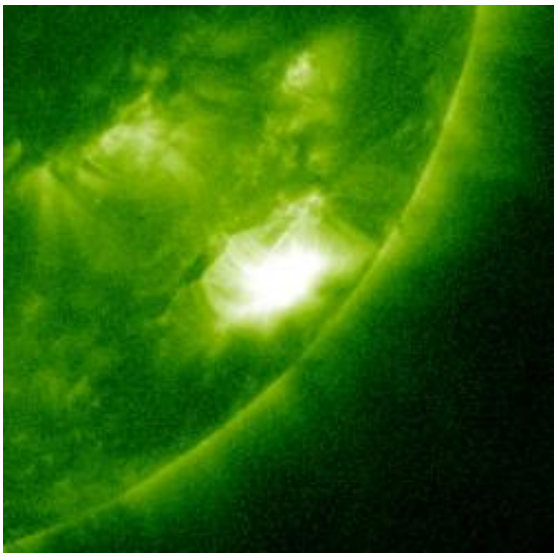
Figure 3b – SDO imagery of AR3100, which produced a long duration C-class flare and a CME (see SDO/AIA 94 and LASCO-c2 images below).





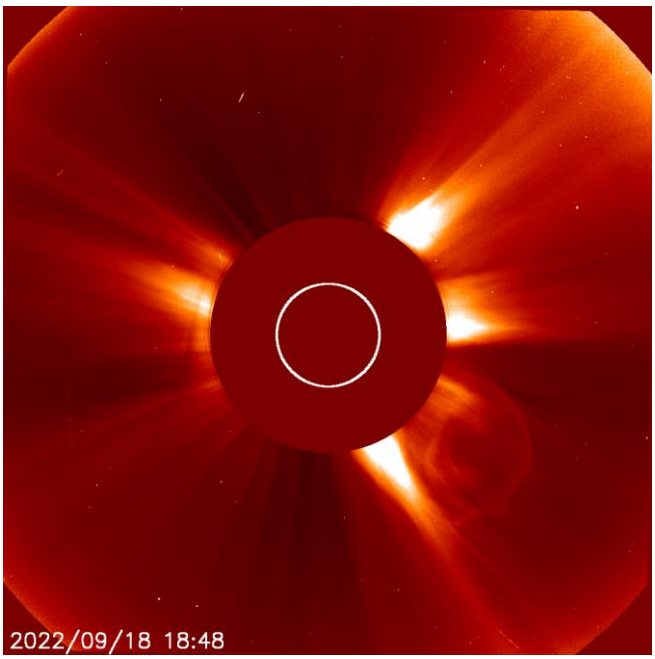


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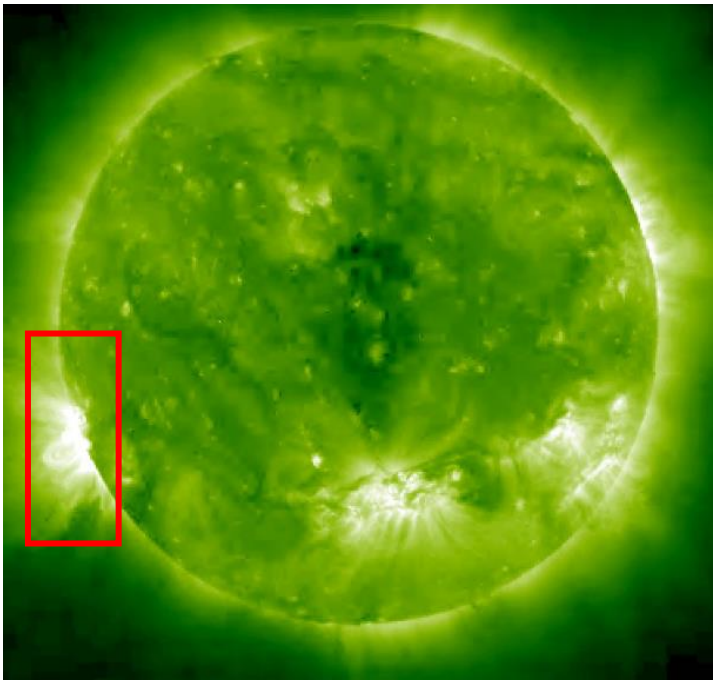
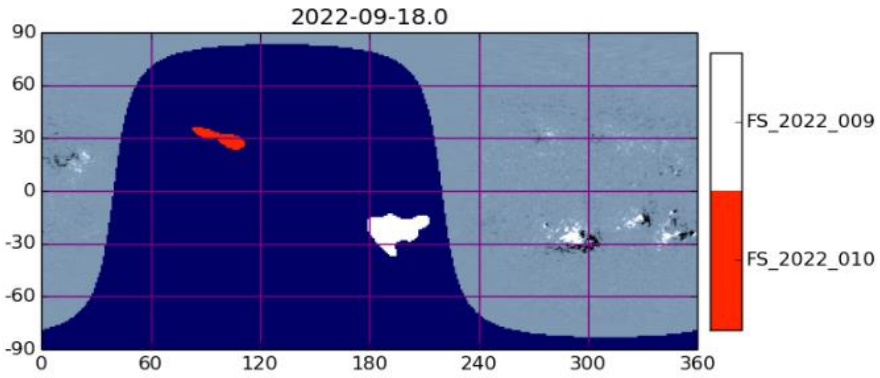
Figure 3c – STEREO-A EUVI and Far-side helioseismograph (Stanford) shows ex-3098 appraching the southeast limb – due to rotate onto the visible disc next few days.





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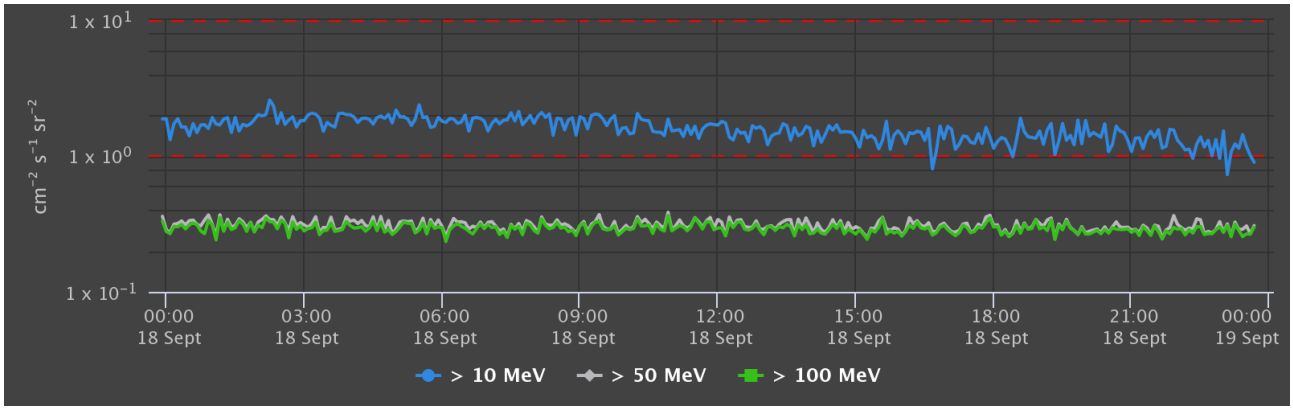
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) observed by GOES-16 remains slightly elevated at above background levels, but below the S1 level. These conditions have persisted for a number of days, with only a gradual decline towards background expected.

AR3098, which has been the source of recent flaring has not resulted in any further notable increased in the observable proton flux at Earth, and has now rotated well beyond the west limb. Whilst it isn't impossible that notable flaring from this region could still result in increased proton flux at Earth, the most likely source of any subsequent enhancement would be from any activity from AR3102 which is now approaching the central southern disc. This giving a very slight chance of reaching the S1 level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	3	3
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 Proton Flux



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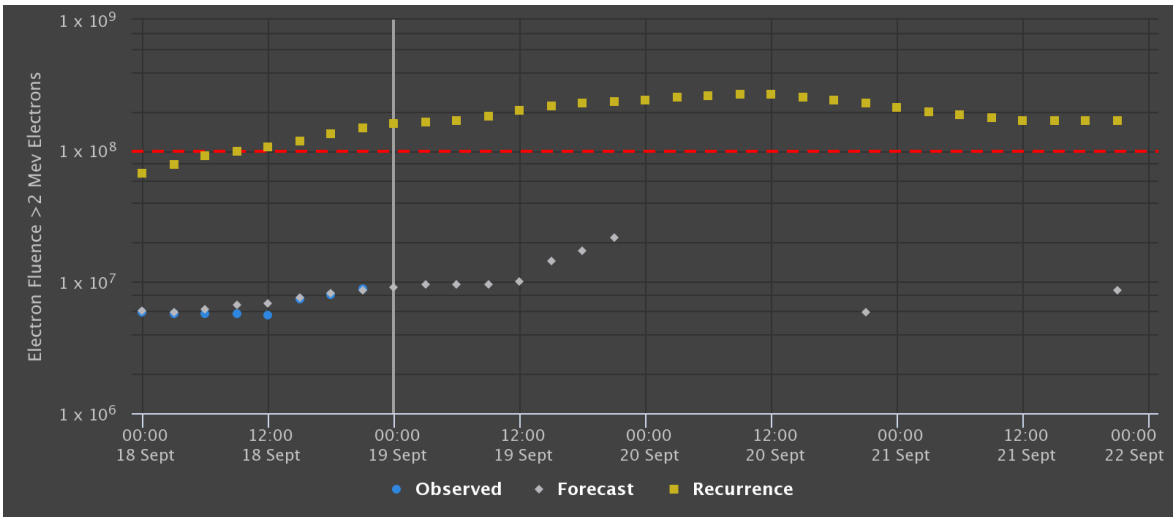
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) as observed by GOES-16, is currently at Background to Moderate levels. Flux levels are expected to rise either ion day 1 (19th) or potentially day 2 (20th). This may result in flux reaching High at diurnal maximum, but due to the relatively limited connection expected to CH23 alongside only possible glancing CME interaction, persistently high flux is only a low risk.

The associated 24 hr fluence is expected to remain below the Active threshold, albeit with a rising trend in response to any elevated flux. REFM has yet to show any forecast increasing trend due to recent solar wind enhancement, and whilst 27-day recurrence is currently running above the Active threshold, this was due to a much stronger fast wind connection on the last rotation.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	20	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: REFM Electron Fluence



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